Advanced Genetic Studies Seek to Enhance Carbon Sequestration in Plants and Soils

Stan Wullschleger

(presented by Robin Graham)

Environmental Sciences Division

Oak Ridge National Laboratory

WullschlegSD@ornl.gov

Carbon Sequestration Conference, 2005

Paper 246

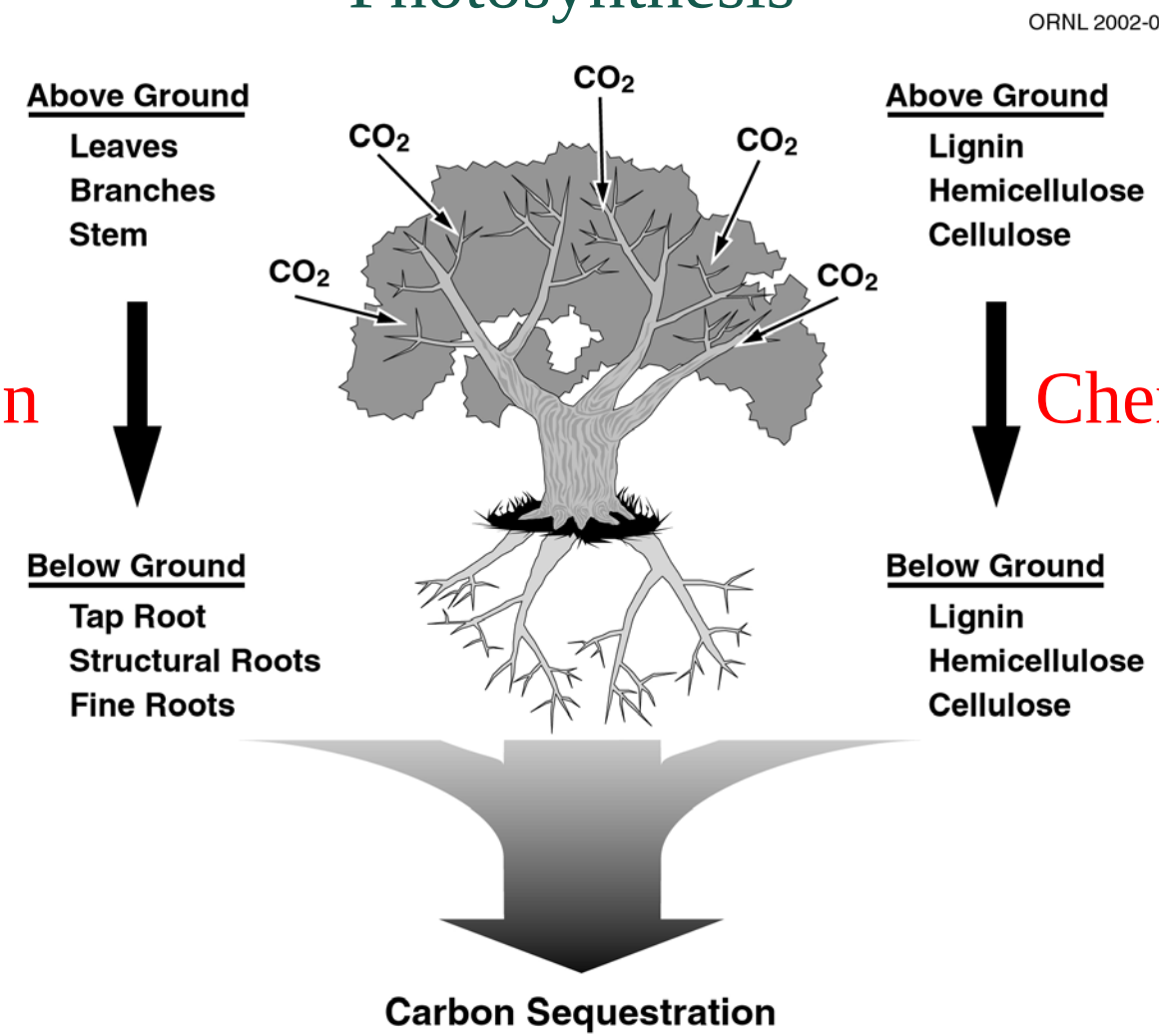
Project Goal

Understand the fundamental genetic and molecular controls on plant-based processes that are important for carbon sequestration in terrestrial ecosystems.

Primarily focus on

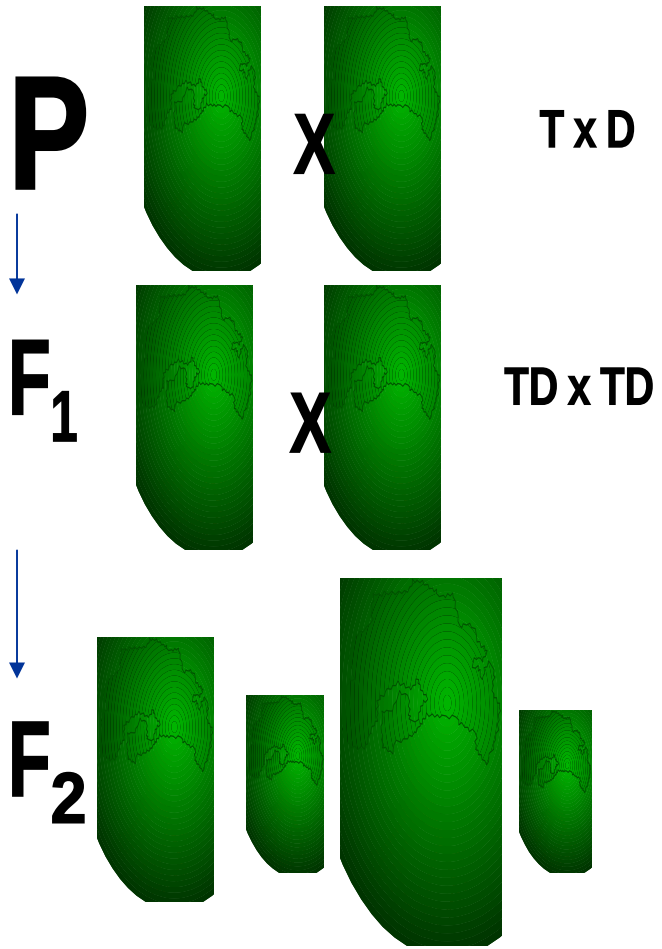
Biomass distribution and tissue chemistry

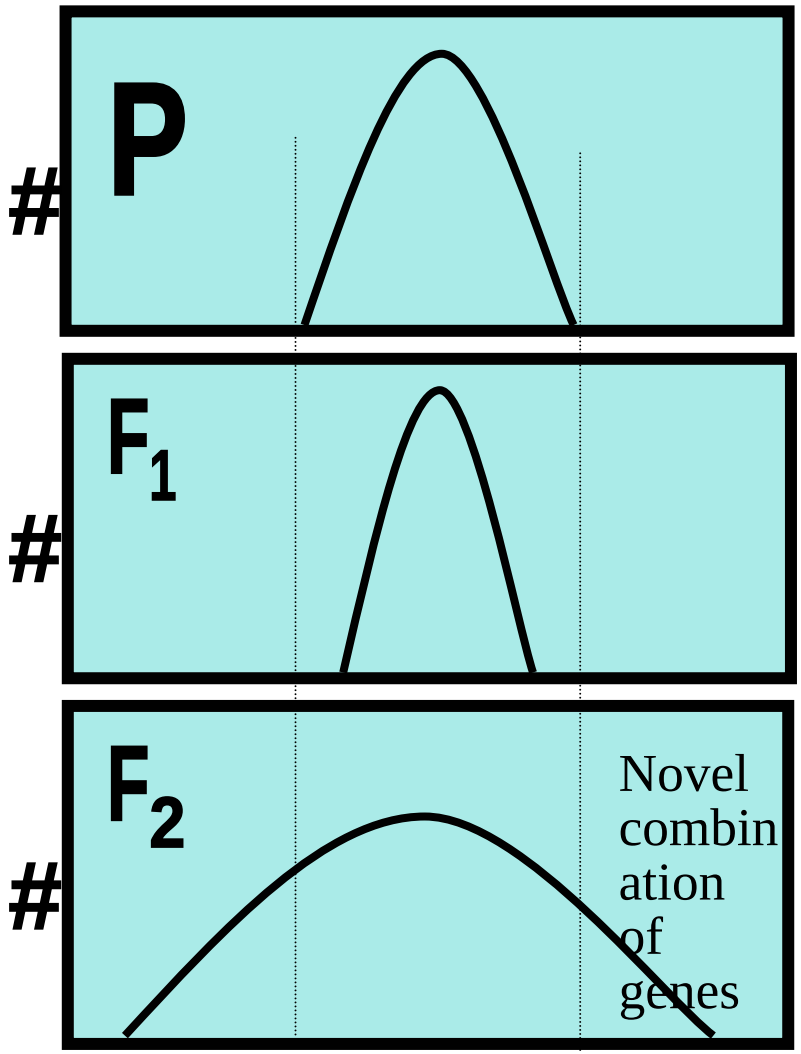
Photosynthesis



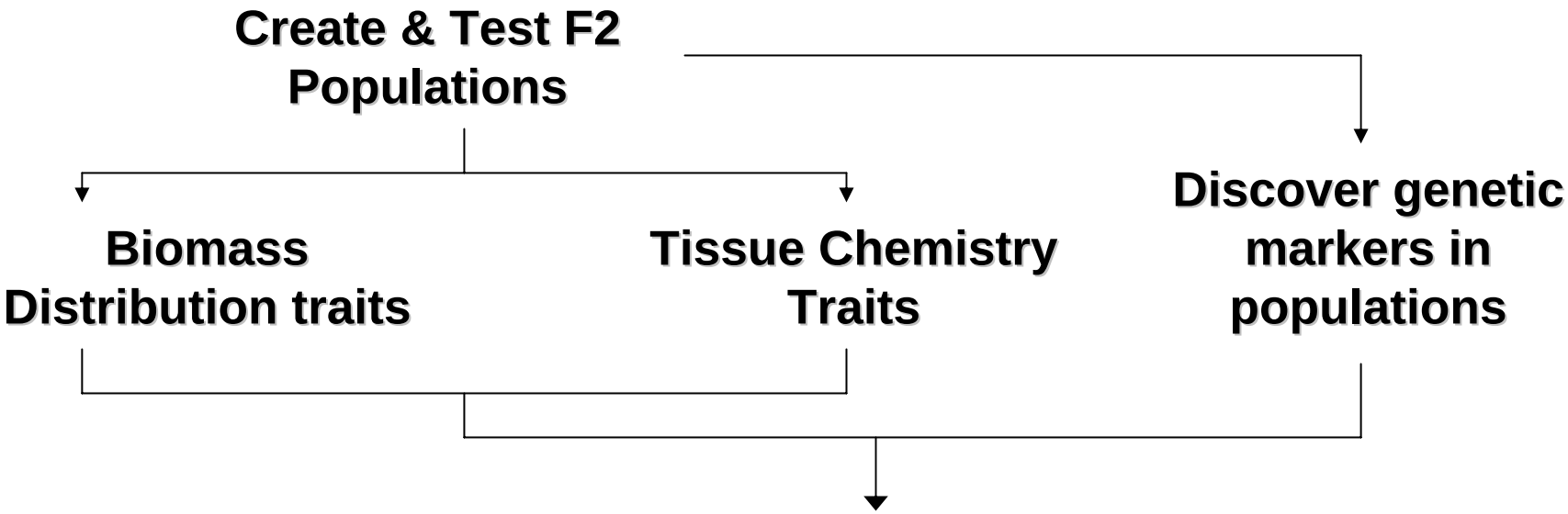
Is there genetic variation in allocation and chemistry traits?

Breeding as a tool to explore genetic variation in traits of interest





Technical Approach



Through QTL analysis determine if observed trait variation is statistically related to genetic markers (regions of the chromosomes)

If yes, then

1) the trait is under genetic control and can be "bred" for
2) further research can discover & describe the genes

Populus as a Model Organism

- Cottonwoods
- Aspens

- Clonal propagation
- 6 to 10 year rotation

- Genome has been sequenced -


Boise Cascade
Fiber Farm
Administrative Office
No Smoking On Boise Cascade Property

Planting and Harvest
of F2 populations

FY2000

Family 331

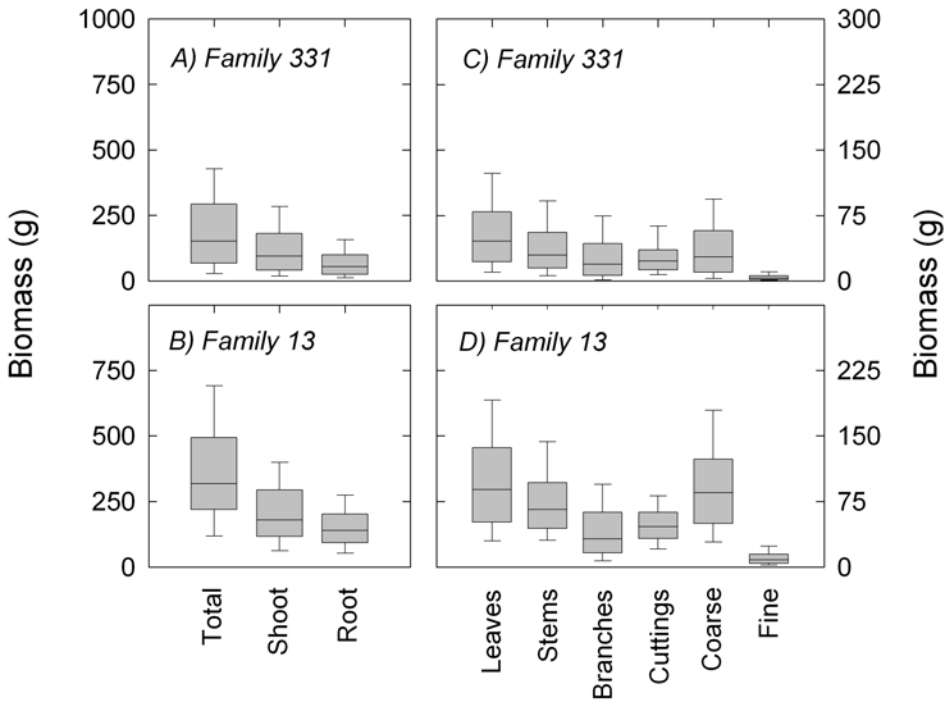
FY2001

Family 13

Harvest of Two-Year-old Plants

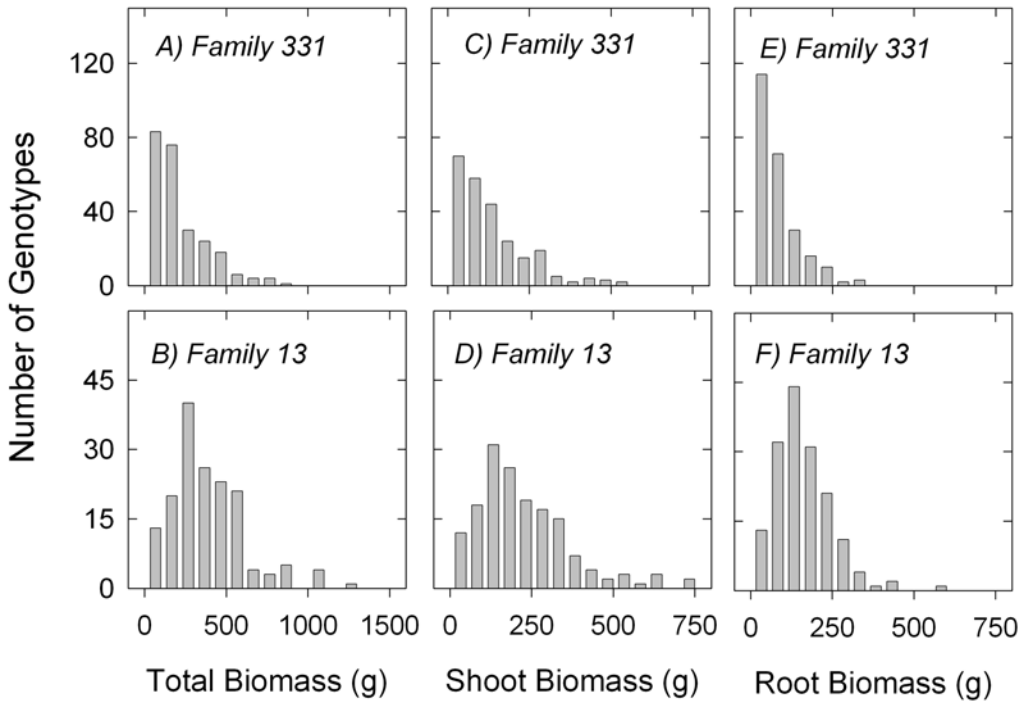
>1000 plants (genotypes) harvested

Biomass Distribution



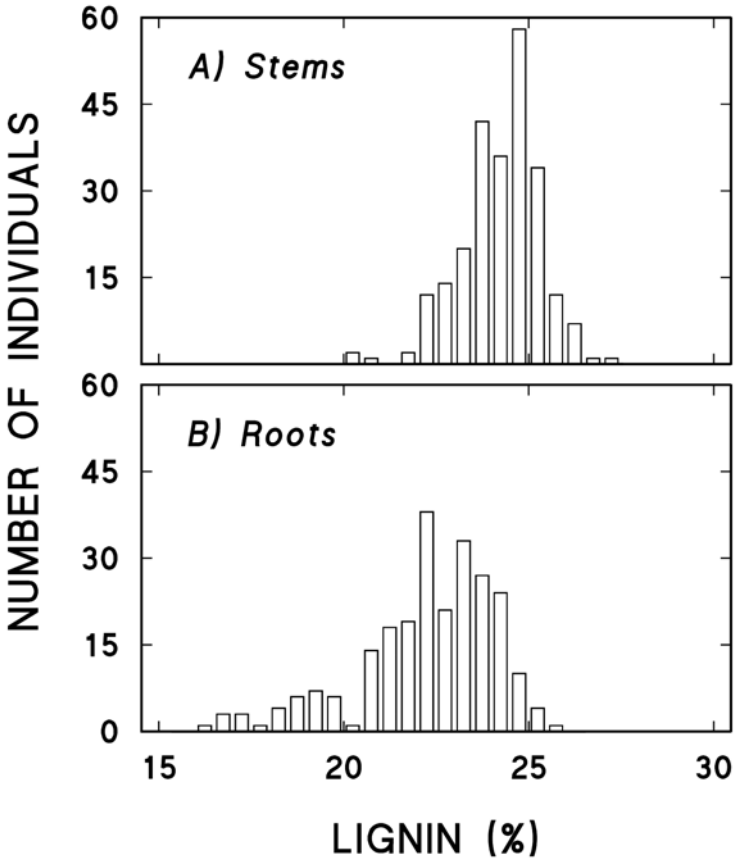
Distribution of above- and below-ground biomass varies widely among individuals.

Biomass Distribution



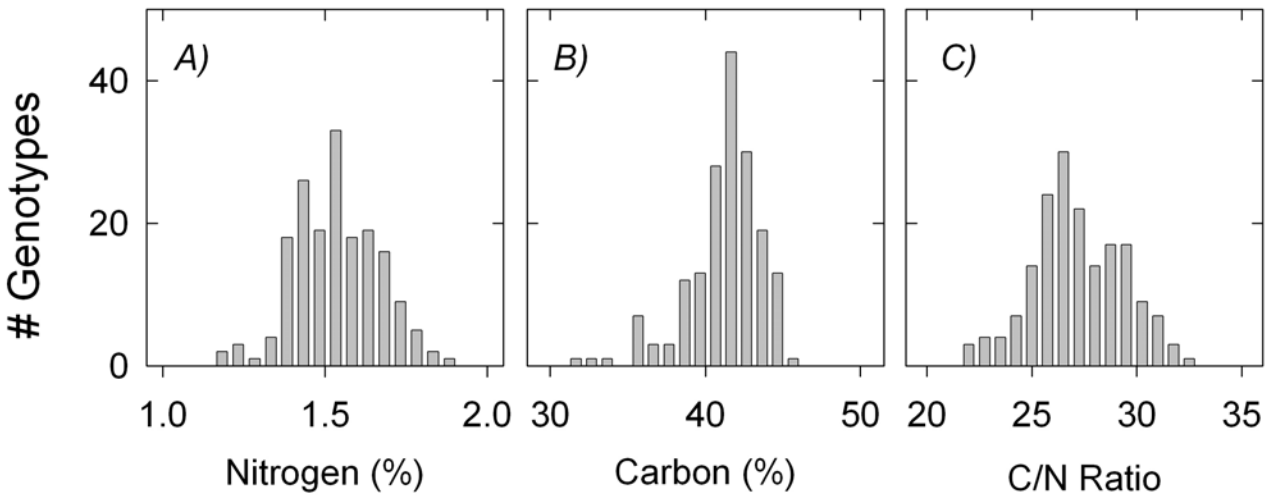
Some genotypes allocate biomass preferentially to either shoots or roots.

Tissue Chemistry



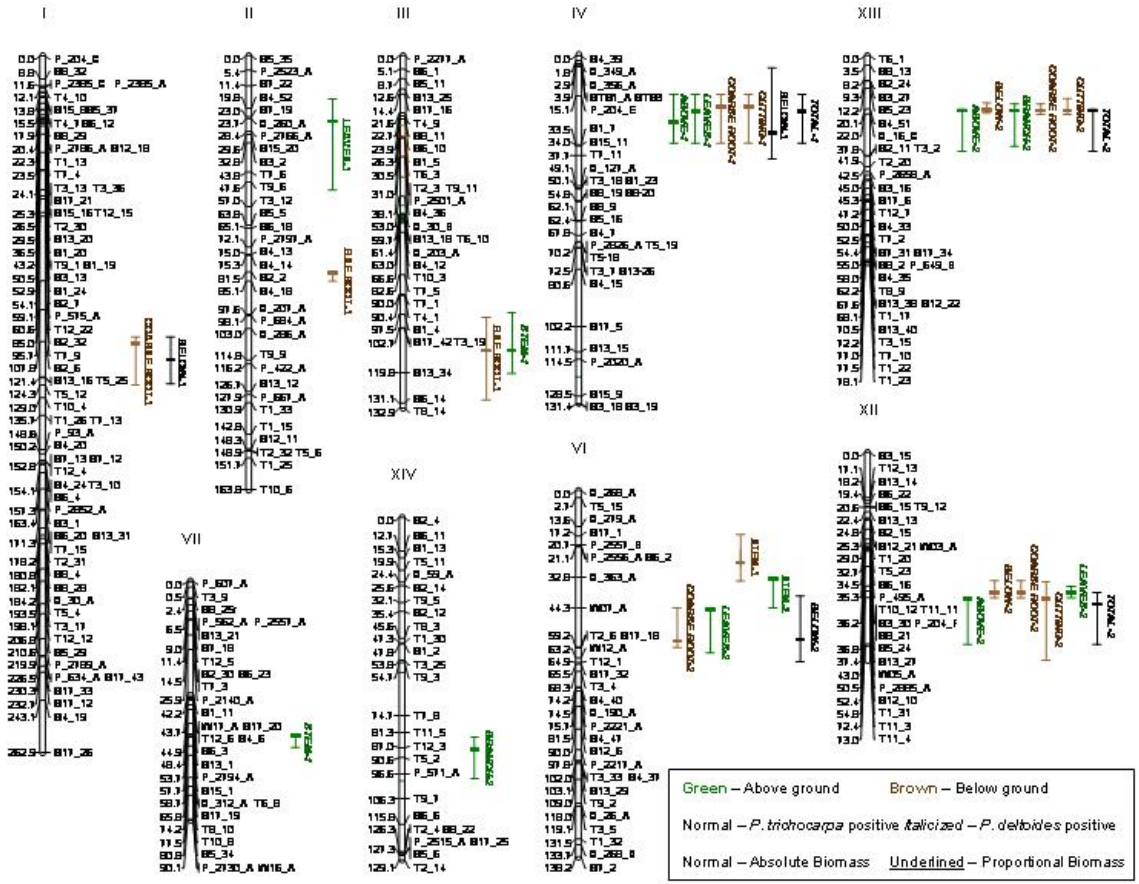
Lignin concentration of stems and roots also varies among individuals within the F2 populations.

Tissue Chemistry



Nitrogen, carbon, and C/N ratio varies among individuals within F2 population.

Do carbon allocation and tissue chemistry genes exist within the *Populus* genome ?



Yes, observed variations in traits could be correlated with 31 locations on the genome. Also, chemistry and allocation patterns were not correlated

Conclusions

1. Significant variability in dry mass distribution above- and below-ground.
2. Significant variability in tissue chemistry.
3. Traits are under genetic control.
4. These QTLs can be used in gene discovery.
5. Genetic variation in biomass distribution and tissue chemistry suggest that advanced breeding and marker-aided selection can be used to enhance carbon sequestration in terrestrial ecosystems.

Acknowledgements

Research sponsored by the DOE Office of Science, Office of Biological and Environmental Research, Carbon Sequestration Program